

REMARKS

Claims 1-8 are presently pending in the application.

Claim 6 has been amended for clarity in response to the Examiner's objection in Paper No. 3. No new matter has been added by this amendment. It is believed that claim 6 is in idiomatic English, but if the Examiner disagrees, he/she is requested to telephone the undersigned to request further clarification. Reconsideration and withdrawal of the objection are respectfully requested.

The Examiner has rejected claims 1-8 under 35 U.S.C. §102(e) as being anticipated by each of U.S. Patent No. 6,358,648 of Hayashi et al. ("Hayashi") and U.S. Patent No. 6,083,642 of Kato et al. ("Kato"). Applicants respectfully traverse these rejections and the arguments in support thereof as follows, and respectfully request reconsideration and withdrawal of the rejections.

Rejections Under §102(e) Based on Hayashi and on Kato

The Examiner argues, regarding claims 1, 3, 4, 6, and 7, that Hayashi teaches a nickel electrode active material for alkaline storage batteries comprising nickel hydroxide. Spherical powders (mean particle circularity is equivalent to 1) of solid solute nickel hydroxide incorporating one or two elements selected from cobalt, cadmium, zinc, and magnesium are allegedly produced. The Examiner contends that the mean particle size of the resulting powder is about 10 μm in another similar embodiment. Further, Hayashi allegedly teaches that the resulting nickel hydroxide particles have better crystal growth and more homogeneous crystals along certain crystal planes than conventional nickel hydroxide and as a result, the decrease in the number of disordered crystals suggests uniform progress of the charge reaction of nickel hydroxide to nickel oxyhydroxide. Thus, the Examiner concludes that the positive electrode active material would inherently comprise nickel oxyhydroxide upon charging the battery. Moreover, the Examiner takes the position that since the positive electrode active materials disclosed by Hayashi and the present application have similar chemistry and manufacturing procedures, other properties of the Hayashi material, such as BET surface area, particle size distribution and full width at half maximum of a particular crystallographic orientation, are inherent.

Regarding claim 2, the Examiner contends that Hayashi teaches solid solution nickel hydroxide powders that are produced by dissolving a sulfate of one or two elements, including cobalt, cadmium, zinc and magnesium, in the nickel sulfate solution. Therefore, the Examiner concludes that the resulting positive electrode active material would have a cobalt compound on a portion of the surface. Regarding claim 5, Hayashi allegedly discloses that the solid solution nickel hydroxide powders are spherical, and that essentially all of the powders have a circularity of 1. Finally, the Examiner argues, regarding claim 8, that Hayashi teaches that the positive electrode active material is first mixed with a cobalt powder, a cobalt hydroxide powder, and a zinc oxide powder. Water is then added to the mixture and kneaded to make a paste, which is filled onto a foamed porous nickel substrate. Based on these teachings, the Examiner contends that Hayashi anticipates all of the pending claims, a rejection which Applicants respectfully traverse as set forth below.

Regarding claims 1-4, 6, and 7, the Examiner further argues that Kato teaches a positive electrode material for an alkaline storage battery. The active material allegedly comprises nickel hydroxide particles and a higher cobalt oxide (γ -cobalt oxyhydroxide). The positive electrode material is allegedly prepared by coating the surface of nickel hydroxide particles with the higher cobalt oxide. The nickel hydroxide particles are a solid solution material with one or more metallic element other than nickel, including cobalt, cadmium, and zinc. The solid solution nickel hydroxide particles with the cobalt oxide coating have an average particle diameter of 5 to 20 μm and a BET specific surface area of 5 to 12 m^2/g . In one embodiment, an aqueous solution containing nickel sulfate as the main component, cobalt sulfate and zinc sulfate are mixed. An aqueous sodium hydroxide solution is slowly added dropwise while adjusting the pH of the solution with aqueous ammonia, thereby depositing spherical solid solution nickel hydroxide particles (having a circularity of 1). Also, Kato allegedly reveals the presence of nickel oxyhydroxide in the positive electrode active material based on the X-ray diffraction and the special calorimeter studies. Moreover, the Examiner takes the position that other properties of the material, such as particle size distribution and full width at half maximum of a particular crystallographic orientation are inherent, given that the positive electrode active materials disclosed by Kato and the present application have similar chemistry and manufacturing procedures.

Regarding claim 5, the Examiner contends that Kato discloses that the solid solution nickel hydroxide powders are spherical, and that essentially all of the powders have a circularity of 1. Finally, the Examiner argues, regarding claim 8, that Kato teaches that the positive electrode active material is first mixed with a cobalt powder, a cobalt hydroxide powder, and a zinc oxide powder. Water is then added to the mixture and kneaded to make a paste, which is filled onto a foamed porous nickel substrate. Based on these reasons, the Examiner contends that Kato anticipates all of the pending claims, which Applicants respectfully traverse as follows.

The present application is directed to a positive electrode active material for an alkaline storage battery containing a nickel hydroxide powder and/or a nickel oxyhydroxide powder, in which the positive electrode active material exhibits particular physical properties, and a method of making a positive electrode using such positive electrode active material. Applicants concede that there are similarities among the production methods described in the present application, Hayashi, and Kato, namely, that nickel hydroxide is obtained by reacting nickel sulfate with sodium hydroxide. However, the reaction conditions in the cited references are different from those in the present application. Such differences are significant because they affect the physical properties of the resulting nickel hydroxide powder. Applicants have found that by controlling the shape and size of the active material and thus the properties of the paste containing the active material, as well as by reducing variation in the filled amounts of the active material in the positive electrodes, a high capacity battery is obtained. Further, since the shapes of the particles are uniform, they are less distorted during charge/discharge of the electrode due to swelling with the electrolyte, resulting in a battery with long cycle life.

In Example 1 of the present application, the nickel hydroxide powder was produced using the following conditions: (1) an aqueous solution of sulfate containing nickel and zinc was used as a starting aqueous solution; (2) this starting aqueous solution was kept at 25°C; (3) the starting aqueous solution was supplied into a reaction vessel with the temperature maintained at 35°C; and (4) the pH of the reaction vessel was maintained at 12 (page 23, line 12 to page 24, line 19).

In contrast, while Hayashi teaches that the active material was produced by mixing an aqueous nickel sulfate solution with an aqueous sodium hydroxide solution, no specific reaction conditions are disclosed. Similarly, Kato teaches in col. 11, lines 49-63 that

nickel hydroxide was synthesized using a known technique: an aqueous sodium hydroxide solution was slowly added dropwise to an aqueous solution containing nickel sulfate as a main component and prescribed amounts of cobalt sulfate and zinc sulfate, while adjusting the pH of the solution with aqueous ammonia. Spherical solid solution nickel hydroxide particles were thus deposited. However, Kato does not provide specific values of the temperature or pH of the reaction vessel, nor disclose a specific temperature of the starting aqueous solution.

As mentioned above and as taught at page 22, lines 11-18 of the present application, Applicants have found that it is possible to manipulate physical properties of the active material (composition, particle circularity, particle size, specific surface area, and crystallinity) by managing and carefully controlling reaction conditions such as the composition, concentration, temperature and flow rate of each of the various solutions, as well as the temperature, pH, stirring rate, and retention time of the aqueous solution in the reaction vessel. For example, the powders of Examples 1 and 2 and of Comparative Example 1 of the present application were prepared by different methods. While the powder of Example 1 was prepared using the conditions summarized above, that of Example 2 was prepared using an increased stirring rate for the aqueous solution of NaOH in the reaction vessel at 35°C having a pH of 12. In the Comparative Example, the temperature of the starting aqueous solution was not controlled. As can be seen in the Table below, the physical properties of the powders produced by the three methods are different. Most noticeably, the circularity, particle size and specific surface area of the Comparative powder differ from those of Powders of Examples 1 and 2. When the mean circularity is smaller than 0.95, as in the Comparative powder, the properties of the paste containing the active material become unstable, reducing the active material density in the positive electrode and the capacity of the positive electrode and thus deteriorating the high rate discharge characteristics of the battery. Applicants have thus discovered the ideal reaction conditions to produce the optimum physical properties of the active material powder which should be used to obtain excellent battery characteristics.

		Present Application			Hayashi	Kato
		Ex. 1	Ex. 2	Comp. Ex. 1	Ex. 1	Ex. 1
Material	Ni	Composition	NiSO ₄	NiSO ₄	NiSO ₄	NiSO ₄
		Temp.	25°C	25°C	-----	-----
	Zn	Composition	ZnSO ₄	ZnSO ₄	ZnSO ₄	ZnSO ₄
		Temp.	25°C	25°C	-----	-----
	Co	Composition			-----	CoSO ₄
		Temp.			-----	-----
Ni/Zn		9/1	9/1	9/1	-----	-----
	NaOH	Temp.	25°C	25°C	-----	-----
Reaction vessel		Temp.	35°C	35°C	35°C	-----
		pH	12	12	12	-----
		stirring	done	strong	Weak	-----
Powder Physical properties		circularity	0.95	0.96	0.94	
		Particle size	13.0	12.8	14.0	
		Specific surface area	12	12	14	
		FWHM (101)	0.95	0.95	0.95	
		(001)/(101)	1.4	1.4	1.4	
		Circularity of 0.85 or smaller	10%	5%	10%	

In a known, typical method for producing nickel hydroxide, a general practice is to control the pH and the temperature of the reaction vessel but not to control the temperature of the starting aqueous solution, as in Comparative Example 1. Therefore, since both Hayashi and Kato are silent about specific reaction conditions, it is reasonable to assume that the nickel hydroxide powders produced in the cited references were produced by traditional methods, and that the active material powders obtained by the production methods of Hayashi and Kato are

comparable to that of Comparative Example 1 of the present application. It may be further assumed that since neither Hayashi nor Kato teaches or suggests anything to the contrary, the mean circularity values of the nickel hydroxide powders in both Hayashi and Kato are smaller than 0.95, as in Comparative Example 1, rather than not smaller than 0.95 to not larger than 1 as claimed. Similarly, since both references are silent as to the claimed properties and their effect on battery performance, there is no basis for assuming that particles having all of the same physical properties would be obtained by the prior art references and according to the present application, and inherency has not been demonstrated.

Further, the Examiner argues, regarding the circularity of the active materials in Hayashi and Kato, that the active materials disclosed in both references are spherical, i.e., the circularity of those active materials is equivalent to 1. In practice, however, the powders obtained in these references cannot be considered as completely spherical. As previously demonstrated, mean circularity usually varies, depending on production conditions, and is typically smaller than 0.95, as described in the application. Even when the mean circularity value is 0.95 or larger as in Example 1, for example, particles having a circularity of 0.85 or smaller are also present. It is therefore extremely difficult, from a practical standpoint, to obtain a mean circularity value of nickel hydroxide powders equivalent to 1 (namely, to prepare only spherical powders). Accordingly, the Examiner's remark that "the active materials disclosed in Hayashi and Kato are spherical and essentially all the powders thus have a circularity of 1" is incorrect.

Finally, the effects obtained by the present application and the cited references are different. As previously explained, when the shapes and physical properties of the active material powders are made uniform, variations in the filled amount of the active material are reduced, thereby allowing constant supply of a high-capacity battery. Further, when the particle shapes are made uniform, degradation of an electrode due to the swelling is suppressed, thereby providing a battery with a long cycle life.

In contrast, Hayashi teaches that capacity and cycle life of an alkaline storage battery can be improved due to reduction in the amount of SO_4^{2-} contained in nickel hydroxide. Accordingly, in Hayashi, nickel hydroxide produced by a common production method is treated with sodium hydroxide to reduce the amount of SO_4^{2-} . Kato teaches that utilization of a positive electrode active material can be improved by using cobalt oxide in a highly oxidized state mainly

composed of γ -cobalt oxyhydroxide. Therefore, although Applicants, Hayashi, and Kato have achieved similar effects in terms of improved capacity and cycle life, different mechanisms were used to achieve these results.

In summary, because Kato and Hayashi do not teach or suggest specific reaction conditions for producing an active material, the methods may not be assumed to be identical. Therefore, there is no basis for concluding that the physical properties of the respective powders are the same. Accordingly, the claimed physical properties are not inherent in the powders of Hayashi or Kato, and neither reference anticipates the present claims.

Finally, the present invention makes it possible to provide uniform active materials by converting the shapes and other physical properties of active materials into numerical values. Neither Hayashi nor Kato clearly discloses the shapes and other physical properties of active materials as in the application nor that these properties would have an effect on the resulting batteries. Since such effects are unexpected, they further rebut any case of anticipation based on inherency. Accordingly, reconsideration and withdrawal of the § 102(e) rejections are respectfully requested.

In view of the above Amendment, the claims comply with all formalities. Further, in view of the preceding Remarks, Applicants respectfully submit that the pending claims are patentably distinct over the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

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